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The Effect of Nasal Septum Deviation on The Degree of Mastoid Pneumatization

Abstract

Objective: Investigations show that nasal septum deviation changes the paranasal sinus volume on the deviation side and affects the middle ear pressure. In this study, we investigated the relationship between the degree of nasal septum deviation and the pneumatization degree of the mastoid bone air cell system.

Methods: This retrospective study evaluated data collected from February 2018 to January 2020 at Amasya University Sabuncuoglu Serefeddin Training and Research Hospital The nasal deviation direction and the angle of septal deviation in coronal sections were recorded, and the mastoid bone pneumatization was classified. Then, the relationship between the nasal septum deviation and the mastoid pneumatization was evaluated.

Results: There was a statistically significant difference between the rate of the right mastoid pneumatization level in relation to the direction of nasal septum deviation. Otherwise, no statistically significant differences were found in the left mastoid pneumatization between the areas to the right and left of the nasal septum deviation.

Conclusion: The results showed that mastoid pneumatization significantly affected those with a deviation of the nasal septum to the right, resulting in a significant reduction in volume on the ipsilateral side. However, on the opposite side of the deviation, the mastoid pneumatization was reduced, although not as much as on the deviation side. These results suggest that nasal septum deviation may also affect mastoid pneumatization.

Keywords: nasal septal deviation, mastoid pneumatization, angle of nasal septal deviation

Introduction

Nasal septum deviation is the most common congenital or acquired nasal deformity. The prevalence of nasal septum deviation, based on computed tomography, is reported to be approximately 40%.[1, 2] Nasal septum deviation can cause complications, such as sinusitis, nasal obstruction, meningitis, and cavernous sinus thrombosis.[3] The septum is rarely in the midline in the general population.[4] With nasal septum deviation, the air flow dynamics change on the deviation side.[5,6]

The air cell system of the mastoid bone (ACSMB), which is a posterior cellular extension of the middle ear, regulates and buffers the pressure and temperature fluctuations within the middle ear cavity. The protective effect mechanism is directly proportional to the degree of pneumatization.[7] There are opposing hypotheses to explain the pneumatization of the ACSMB. For one, it is said to be associated with environmental or genetic factors.[6] According to the environmental theory, the mastoid pneumatization degree is defined by the postnatal pathological involvement of the middle ear. To date, there is substantial evidence that mastoid pneumatization can be altered to varying degrees by postnatal environmental factors.[8]

In addition, investigations show that nasal septum deviation changes the volume of the paranasal sinuses on the deviation side and affects the middle ear pressure.[6,9] There are a limited number of studies on this subject in the literature. Thus, in the present study, we aimed to investigate the relationship between the degree of nasal septum deviation and the pneumatization degree of the mastoid air cell system.

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Methods

This retrospective study evaluated data collected from February 2018 to January 2020 at Amasya University Sabuncuoglu Serefeddin Training and Research Hospital. This study was performed in accordance with the ethical standards set forth by the 1964 Declaration of Helsinki. Ethics Committee Approval was also obtained from the Amasya University Clinical Researches Ethics Committee (Date: 19/01/2021- Number: E-15386878-044-1697). The study population included all the paranasal sinus scans and mastoid views, which were archived in the imaging section. The inclusion criterion was the presence of a deviated septum in radiography. Patients with sinonasal polyps, chronic otitis media, chronic sinusitis, concha bullosa, those below 18 years, those with septoplasty or endoscopic sinus surgery history, those with sinonasal neoplasm, and those with a history of maxillofasial trauma were excluded from the study. The study included a total of 100 patients diagnosed with nasal septal deviation. The nasal deviation direction and the angle of septal deviation in coronal sections were recorded, which showed the maximum deviation of the nasal septum. The angle of the nasal septum was defined as the angle between a line drawn from the Crista Galli to the lower portion of the nasal septum in the maxillary spine and another line drawn from the upper nasal septum in the Crista Galli to the most deviated point of the nasal septum. The patients were divided into 3 groups based on the angle of the septal deviation as follows: mild (less than 9°); medium (between 9°-15°); and severe (more than 15°).[10] The classification of the ACSMB pneumatization was performed as (complete pneumatization), diploic (partial pneumatization), or sclerotic (pneumatization absent).[11] Then, the relationship between the nasal septum deviation and the mastoid pneumatization was evaluated.

Statistical Analysis

Based on the data obtained from the study, the descriptive statistics were tabulated as the mean ± standard deviation and the median, minimum, and maximum, depending on the distribution for the continuous (numerical) variables. The categorical variables were summarized as numbers and percentages. The normality test of the numerical variables was checked by the Shapiro-Wilk, Kolmogorov-Smirnov and Anderson-Darling tests.

For the comparison of two independent groups, a Mann-Whitney U test was used in the cases where the numerical variables did not show a normal distribution.

For the comparisons with more than 2 independent groups, the Kruskall-Wallis H test was used in the cases where the numerical variables did not show a normal distribution. The differences between the groups for the nonparametric tests were evaluated by the Dwass-Steel-Critchlow-Fligner test.

Main points

- Nasal septum deviation affects mastoid aeration.
- When an operation related to ear pathologies is planned, nasal cavity ventilation should be provided first, due to the correlation between nasal septum deviation and mastoid bone aeration.
- When patients apply to us with a nasal pathology or an ear-related pathology, they should be evaluated from many perspectives. It should be kept in mind that nasal pathologies that are not corrected in time will lead to ear-related pathologies, and if nasal pathology is ignored while treating ear-related pathologies, treatment success will decrease.

The Spearman's Rho correlation coefficient was used in the cases in which there was not a normal distribution when examining the relationships among the numerical variables.

When comparing the differences between the categorical variables, according to the groups, the Pearson Chi-Square test was used in 2x2 tables with an expected cell number of 5 and above, a Fisher's Exact Test was used in the tables with an expected cell number below 5, while the Fisher Freeman Halton test was used in the RxC tables with an expected cell number below 5.

Statistical analyses were performed using the Jamovi project (2020) [Computer Software] (Jamovi Version 1.6.9.0, Jamovi, Sydney, Australia) and JASP (JASP Version 0.14.1.0, JASP, Amsterdam, The Netherlands) programs, and the significance level was set at 0.05 (*P*-value).

Results

The mean age of the 100 patients included in the study was 30.7 ± 10.8 years, and 54 were men and 46 were women. At total of 63% of the nasal septum deviations were to the right. The mean deviation of the nasal septum was an angle of 11.5° ± 5.3°.

Altogether, 41% of the nasal septal deviations were mild, 36% were moderate, and 23% were severe. The right mastoid pneumatization was found to be diploic in 44%, it was aerated in 37% and was sclerotic in 19% of the patients. Likewise, for the left mastoid pneumatization, 46% of the patients were aerated and 46% showed a diploic level (Table 1).

Table 1. Demographic and Clinical Characteristics of Patients with Nasal Septum Deviation

Year	30.7 ± 10.8 / 27.5 [18 - 60]
Gender	
Female	46 (46)
Male	54 (54)
Nasal septum deviation direction	
Right	63 (63)
Left	37 (37)
The angle of nasal septal deviation	11.5° ± 5.3° / 10.3° [3.7° - 27.9°]
Classification of nasal septal deviation	
Mild	41 (41)
Moderate	36 (36)
Severe	23 (23)
Right mastoid pneumatization	
Aerated	37 (37)
Diploic	44 (44)
Sclerotic	19 (19)
Left mastoid pneumatization	
Aerated	46 (46)
Diploic	46 (46)
Sclerotic	8 (8)

Descriptive statistics are mean, standard deviation and median, minimum and maximum for numerical variables; for categorical variables, the number was given as a percentage.

No statistically significant differences were detected between women and men in terms of the direction, angle, severity of the nasal septal deviation, and the right and left mastoid pneumatizations (Table 2).

There was a statistically significant difference between the rate of the right mastoid pneumatization level in relation to the direction of the nasal septum deviation (Table 3). Accordingly, the percentage of those with aerated pneumatization (62.2%) and a

Table 2. Comparison of nasal septum deviation direction, angle, severity and right and left mastoid pneumatization according to gender

	Gender		
	Female (n = 46)	**Male (n = 54)**	***P***
Nasal septum deviation direction			
Right	29 (63)	34 (63)	0.993*
Left	17 (37)	20 (37)	
The angle of nasal septal deviation	8.8°[4.2° - 23.5°]	10.6° [3.7° - 27.9°]	0.129**
Classification of nasal septal deviation			
Mild	24 (52.2)	17 (31.5)	0.083*
Moderate	12 (26.1)	24 (44.4)	
Severe	10 (21.7)	13 (24.1)	
Right mastoid pneumatization			
Aerated	21 (45,7)	16 (29,6)	0.178*
Diploic	19 (41,3)	25 (46,3)	
Sclerotic	6 (13)	13 (24,1)	
Left mastoid pneumatization			
Aerated	26 (565)	20 (37)	0.163*
Diploic	17 (37)	29 (537)	
Sclerotic	3 (65)	5 (93)	

Descriptive statistics are the median, minimum and maximum for numerical variables; For categorical variables, the number was given as a percentage.
*Pearson Chi-Square, Fisher's Exact or Fisher Freeman Halton tests were used.
**Mann-Whitney U test was used.

Table 3. Comparison of the direction of nasal septum deviation with age, gender, angle and severity of nasal septum deviation, and right and left mastoid pneumatization

	Nasal septum deviation direction		
	Right (n = 63)	**Left (n = 37)**	***P***
Year	25 [18 - 60]	30 [18 - 59]	0.134
Gender			
Female	29 (46)	17 (45.9)	0.993*
Male	34 (54)	20 (54.1)	
The angle of nasal septal deviation	10.5° [3.7° - 27.9°]	9° [5.5° - 24.6°]	0.570**
Classification of nasal septal deviation			
Mild	23 (36.5)	18 (48.6)	0.363*
Moderate	23 (36.5)	13 (35.1)	
Severe	17 (27)	6 (16.2)	
Right mastoid pneumatization			
Aerated	14 (22.2)	23 (62.2)	<0.001*
Diploic	34 (54)	10 (27)	
Sclerotic	15 (23.8)	4 (10.8)	
Left mastoid pneumatization			
Aerated	33 (52.4)	13 (35.1)	0.128*
Diploic	27 (42.9)	19 (51.4)	
Sclerotic	3 (4.8)	5 (13.5)	

Descriptive statistics are the median, minimum and maximum for numerical variables; for categorical variables, the number was given as a percentage.
*Pearson Chi-Square, Fisher's Exact or Fisher Freeman Halton tests were used.
**Mann-Whitney U test was used.

Table 4. Correlation of the severity of nasal septal deviation with right and left mastoid pneumatization

	Classification of nasal septal deviation		
	Mild (n = 41)	Moderate (n = 36)	Severe (n = 23)
Right mastoid pneumatization			
Aerated	16 (39)	14 (38.9)	7 (30.4)
Diploic	17 (41.5)	17 (47.2)	10 (43,5)
Sclerotic	8 (19.5)	5 (13.9)	6 (26,1)
Left mastoid pneumatization			
Aerated	20 (48.8)	16 (44.4)	10 (43.5)
Diploic	16 (39)	18 (50)	12 (52.2)
Sclerotic	5 (12.2)	2 (5.6)	1 (4.3)

Descriptive statistics were given as numbers, percentages.

deviation on the left was significantly higher than those with a deviation on the right (22.2%).

On the other hand, no statistically significant differences were found in age, sex, the angle of the nasal septal deviation, the nasal septal deviation classification, and the left mastoid pneumatization in relation to the direction of the nasal septum deviation (Table 3).

The descriptive statistics for the right and left mastoid pneumatization levels, according to the classification of the nasal septal deviation, are presented in Table 4. When the relationship between these was investigated, no significant correlation was found between the severity of the nasal septal deviation and the right (r = 0.060; $P = .550$) or left (r = 0.005; $P = .961$) mastoid pneumatization (Table 4).

Discussion

The development of ACSMB is well described in the literature.[2] ACSMB develops with antral ventilation at birth and then with increased growth for up to one year. Following this, a linear growth phase occurs by age six, and a slow increasing phase toward the adult size occurs during adolescence. Although bone growth and air cell growth are similar, ventilation causes bone growth during these stages.[2]

While ACSMB has been proposed as an air reservoir for the middle ear, information about the physiological functions of ACSMB remains unclear. The development of ACSMB starts at the antrum, but some peritubal and hypotympanic cells develop from the eustachian tube and hypotympan, respectively.[2]

It is suggested that the pneumatization of ACSMB is affected by positive pressure through the eustachian tube in the nasopharynx[12] Considering the location of ACSMB, the anatomical variability of the adjacent structures affects the development of mastoid pneumatization. In addition, total nasal airflow and nasopharyngeal positive pressure are effective in the development of ACSMB.[13]

The classification of pneumatization of the mastoid region can be categorized as aerated (complete pneumatization), diploic (partial pneumatization), or sclerotic (pneumatization absent).[11] The present study evaluated ACSMB in the patients according to this classification.

The nose has a partition in the midline that helps equalize the air passing through each cavity. Nasal aerodynamics change when the nasal septum deviates from the midline to any angle. Nasal septum deviation causes reduced air flow on the convex side of the septum.[4] Nasal septum deviation is almost evenly distributed between the right and the left, but some studies also show right dominance.[5] In this study, nasal septum deviation was evaluated and revealed that the rate of the deviation to the right (63%) was higher. However, there were no statistically significant differences in the age, sex, the angle of the nasal septal deviation, the nasal septal deviation classification and the left mastoid pneumatization according to the direction of the nasal septum deviation ($P > .05$).

ACSMB is an independent air reservoir that exchanges air with cushioning pressure changes in the middle ear. In addition, some studies suggest that ethnicity and the use of antibiotics to treat ear diseases have no effect on the ventilation pattern and mastoid bone growth pattern.[5]

The possible role of nasal septum deviation in determining the development of ACSMB has been demonstrated considering the proximity of both structures. A disruption of air flow, as a result of nasal septum deviation, can cause imperfect pneumatization of ACSMB.[4,14] Although deviation of the nasal septum is thought to impair ACSMB and the pneumatization of other paranasal sinuses, there is no definite correlation.[6]

Karakaş and Kavaklı[15] have reported that the volumes of paranasal sinuses and the mastoid air cells increase with age, and they found a positive correlation between the ipsilateral paranasal sinuses and mastoid air cells. Tos[16] also suggested that variations of mastoid air cells and the decrease in the ACSMB resulted from the exposure of the middle ear mucosa in childhood to pathological stimuli, such as acute otitis, tubal occlusion, and secretory otitis, at different durations and severities, and again in this study, it was concluded that severe septal deviation caused a decrease in the volume of the mastoid air cells.

In our study, when the right mastoid cell pneumatization was evaluated, it was found that those with a left deviation had better ventilation than those with a right deviation ($P < .05$). However, when the left mastoid pneumatization was evaluated, although a higher rate of good mastoid pneumatization was detected numerically in those with a right deviation, no statistically significant difference was found when compared with those with a left deviation. ($P > .05$).

In another study, the angle of nasal septum deviation was correlated with the volume of ACSMB.[4] In some studies in the literature, when the relationship between the air cell system volume of the mastoid bone and nasal septum deviation was evaluated in adult chronic otitis media cases, there was a larger ACSMB on the contralateral side of severe nasal septum deviation patients.[14] Insufficient pneumatization formation on the side of the nasal septum deviation is also supported by similar findings in previous studies.[5]

When evaluating the opposite side of the nasal septum deviation, one study demonstrated that the mastoid air cell was less aerated and was relatively better than the side of the deviation, suggesting that nasal septal deviation may also affect mastoid ventilation.[17] In our study, there was less mastoid pneumatization on the opposite side of the nasal septum deviation, but it was at a lower rate than the deviation side, which supports the literature. Also, no significant correlation was found between the severity of the nasal septal deviation and right ($P > .05$) or left ($P > .05$) mastoid pneumatization.

Firat et al. [14] found that mastoiditis was significantly associated with sinonasal pathologies. Hindi et al.[18] also reported a positive correlation between mastoid pneumatization and the pneumatization of the sphenoid sinus. The literature also supports that nasal air flow affects the middle ear and mastoid aeration. Maier et al.[19] stated that surgical correction for severe nasal pathologies before tympanoplasties may be beneficial.

Our results showed that mastoid pneumatization significantly was affected those with deviation of the nasal septum to the right, resulting in a significant reduction in volume on the ipsilateral side. However, on the opposite side of the deviation, mastoid pneumatization was reduced, although not as much as the deviation side. These results suggest that nasal septum deviation may also affect both mastoid pneumatization.

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REFERENCES

1. Uygur K, Tüz M, Doğru H. The correlation between septal deviation and concha bullosa. *Otolaryngology-Head and Neck Surgery*. 2003;129(1):33-6.
2. Cinamon U. The growth rate and size of the mastoid air cell system and mastoid bone: A review and reference. *Eur Arch Otorhinolaryngol*. 2009; 266(6):781-786. [Crossref]
3. Sistani SS, Dashipour A, Jafari L, Ghahderijani BH. The Possible associations of nasal septal deviation with mastoid pneumatization and chronic otitis. *Open Access Maced J Med Sci*. 2019; 7(15): 2452. [Crossref]
4. Firat AK, Miman MC, Firat Y, Karakas M, Ozturan O, Altinok T. Effect of nasal septal deviation on total ethmoid cell volume. *Journal of laryngology and otology.* 2006; 120(3): 200-204. [Crossref]
5. Kumar NV, Gugapriya T. Relation between nasal septal deviation and pneumatization of mastoid air cells-A Computerised tomographic study. *Academia Anatomica International.* 2018; *4*(2): 14-18. [Crossref]
6. Lee D-H, Jin K-S. Effect of nasal septal deviation on pneumatization of the mastoid air cell system: 3D morphometric analysis of computed tomographic images in a pediatric population. *J Int Adv Otol.* 2014; 10(3): 251. [Crossref]
7. Magnuson B. Functions of the mastoid cell system: Auto-regulation of temperature and gas pressure. *J Laryngol Otol.* 2003; 117(2): 99-103. [Crossref]
8. Swarts JD, Foley S, Alper CM, Doyle WJ. Mastoid geometry in a cross-section of humans from infancy through early adulthood with a confirmed history of otitis media. *Int J Pediatr Otorhinolaryngol.* 2012; 76(1): 137-41. [Crossref]
9. Gencer ZK, Özkırış M, Okur A, Karaçavuş S, Saydam L. The effect of nasal septal deviation on maxillary sinus volumes and development of maxillary sinusitis. *Eur Arch Otorhinolaryngol*. 2013; 270(12): 3069-3073. [Crossref]
10. Koç A, Ekinci G, Bilgili AM, Akpinar IN, Yakut H, Han T. Evaluation of the mastoid air cell system by high resolution computed tomography: three-dimensional multiplanar volume rendering technique. *J Laryngol Otol*. 2003; 117(8): 595-598. [Crossref]
11. Glasscock ME, Gulya AJ. Glasscock-Shambaugh surgery of the ear. PMPH-USA; 2003.
12. Doyle WJ. The mastoid as a functional rate-limiter of middle ear pressure change. *Int J Pediatr Otorhinolaryngol.* 2007; 71(3): 393-402. [Crossref]
13. Kim J, Song SW, Cho J-H, Chang K-H, Jun BC. Comparative study of the pneumatization of the mastoid air cells and paranasal sinuses using three-dimensional reconstruction of computed tomography scans. *Surg Radiol Anat*. 2010; 32(6): 593-599. [Crossref]
14. Gencer ZK, Özkiris M, Okur A, Karaçavus S, Saydam L. The possible associations of septal deviation on mastoid pneumatization and chronic otitis. *Otol Neurotol.* 2013; 34(6): 1052-1057. [Crossref]
15. Karakas S, Kavaklı A. Morphometric examination of the paranasal sinuses and mastoid air cells using computed tomography. *Annals Saudi Med.* 2005; 25(1): 41-45. [Crossref]
16. Tos M. Mastoid pneumatization. A critical analysis of the hereditary theory. *Acta Otolaryngol.* 1982; 94(1-2): 73-80.
17. Göçmen G, Borahan MO, Aktop S, Dumlu A, Pekiner FN, Göker K. Suppl 2: M5: Effect of Septal Deviation, Concha Bullosa and Haller's Cell on Maxillary Sinus's Inferior Pneumatization; A Retrospective Study. *Open Dent J.* 2015; 9: 282. [Crossref]
18. Hindi K, Alazzawi S, Raman R, Prepageran N, Rahmat K. Pneumatization of mastoid air cells, temporal bone, ethmoid and sphenoid sinuses. Any correlation? *Indian J Otolaryngol Head Neck Surg.* 2014; 66(4): 429-436. [Crossref]
19. Maier W, Krebs A. Is surgery of the inner nose indicated before tympanoplasty? Effects of nasal obstruction and reconstruction on the eustachian tube. *Laryngorhinootologie*. 1998; 77(12): 682-688. [Crossref]